

AMENDMENTS TO THE CLAIMS

1. (Original) A system for determining at least one bone property of a bone sample at at least one point, the system comprising:

a) a transmitting ultrasonic transducer and a receiving ultrasonic transducer, both transducers being confocal transducers, the transducers configured to receive the bone sample therebetween such that the confocal point of the transducers are located at the at least one point in the bone sample; and

b) a processor that initiates an ultrasonic signal from the transmitting transducers that is transmitted through the at least one point of the bone sample when positioned between the transducers and received by the receiving transducer, the processor receiving a signal reflecting one or more measures of the received ultrasonic signal, the processor determining at least one ultrasonic parameter for the at least one point of the bone sample based upon the transmitted and received ultrasonic signals, the processor further determining the at least one bone property at the point of the sample based upon the at least one ultrasonic parameter.

2. (Original) The system as in Claim 1, wherein the bone sample is a bone in a live human being.

3. (Original) The system as in Claim 1, wherein the confocal point of the transmitting and receiving transducers has a resolution equal to approximately 0.5 mm.

4. (Original) The system as in Claim 1, wherein the transmitting transducer emits ultrasonic signals at a frequency on the order of tens of megahertz.

5. (Original) The system as in Claim 1, wherein the system further comprises a three dimensional scanning stage on which the transmitting and receiving transducers are mounted, the three dimensional scanning stage moving the transmitting and receiving transducers in three dimensions to move the confocal point of the transducers to correspond to a number of points in the bone sample when positioned between the transmitting and receiving transducers.

6. (Original) The system as in Claim 5, wherein, for each point in the bone sample corresponding to movement of the confocal point, the processor initiates an ultrasonic signal from the transmitting transducers that is transmitted through the bone sample and received by the receiving transducer, the processor receiving a signal reflecting one or more measures of the received ultrasonic signal, the processor determining at least one ultrasonic parameter for each point in the sample based upon the transmitted and received ultrasonic signals, the processor further determining the at least one bone property at each point of the sample based upon the at least one ultrasonic parameter for the point.

7. (Original) The system as in Claim 6, wherein the three dimensional scanning stage performs a discrete scan.

8. (Original) The system as in Claim 6, wherein the three dimensional scanning stage performs a continuous scan.

9. (Previously Presented) The system as in Claim 5, wherein each point in the bone sample is separated by 0.1 mm.

10. (Original) The system as in Claim 1, wherein the at least one ultrasonic parameter determined for the at least one point of the sample are ultrasonic velocity (UV) and a measure of ultrasonic attenuation (UA).

11. (Original) The system as in Claim 10, wherein UV at the at least one point (x,y,z) of the sample is calculated by the processor as:

$$UV_{(x,y,z)} = v_m * w / (w - v_m * \Delta T)$$

where ΔT is the delay between the received ultrasound signal as passed through the bone sample and a reference ultrasound signal received without the sample positioned between the transducers, w is the thickness of bone and v_m is the velocity of ultrasound in ultrasound velocity in a medium in which the bone is immersed.

12. (Original) The system as in Claim 10, wherein the measure of UA is one selected from the group of broadband ultrasonic attenuation (BUA) and ultrasonic attenuation number (ATT).

13. (Original) The system as in Claim 12, wherein the measure of UA is BUA, where BUA at the at least one point (x,y,z) of the sample is calculated by the processor as the slope of the linear section of the ultrasound attenuation coefficient function, $UAC_{(x,y,z)}(f)$, where $UAC_{(x,y,z)}(f)$ is calculated from the fast fourier transform (FFT) of frequency f (as a function of time) for the received ultrasound signal $f_{bone}(t)$ as passed through the bone sample and a reference ultrasound signal $f_{ref}(t)$ received without the sample positioned between the transducers in accordance with the following equation:

$$UAC_{(x,y,z)}(f) = 20 \text{ Log } [(FFT(f_{ref}(t)) / (FFT(f_{bone}(t)))].$$

14. (Original) The system as in Claim 12, wherein the measure of UA is ATT, where ATT at the at least one point (x,y,z) of the sample is calculated by the processor from the energy of the received ultrasound signal as passed through the bone sample and the energy of a reference ultrasound signal received without the sample positioned between the transducers in accordance with the following equation:

$$ATT_{(x,y,z)} = 10 * \text{LOG} [(energy of reference signal)_{(x,y,z)} / (energy of bone signal)_{(x,y,z)}].$$

15. (Original) The system as in Claim 12, wherein the at least one bone property determined at the at least one point is bone mineral density (BMD).

16. (Original) The system as in Claim 15, wherein BMD is determined at each point by at least one equation selected from the following group of three equations:

- i) $BMD = e + f * UV + g * BUA$
- ii) $BMD = a + b * UV + c * BUA + d * UV^2$
- iii) $BMD = u + v * UV + w * ATT,$

where e, f and g; a, b, c and d; and u, v and w are constant coefficients, and UV, BUA and ATT are determined for the at least one point of the sample.

17. (Original) The system as in Claim 16, wherein i) e, f and g are linear regression constants predetermined by conducting a regression analysis between measurements of UV and BUA on bone specimens and BMD measurements on the bone specimens using conventional analysis; ii) a, b, c and d are non-linear regression constants predetermined by conducting a regression analysis between measurements of UV and BUA on bone specimens and BMD measurements on the bone specimens using conventional analysis; and iii) u, v and w are linear regression constants predetermined by conducting a regression analysis between measurements of UV and ATT on bone specimens and BMD measurements on the bone specimens using conventional analysis.

18. (Original) The system as in Claim 12, wherein the at least one bone property determined at the at least one point is Stiffness.

19. (Original) The system as in Claim 18, wherein Stiffness is determined by at least one equation selected from the following group of three equations:

- i) $\text{Stiffness} = l + m * \text{UV} + n * \text{BUA}$
- ii) $\text{Stiffness} = h + i * \text{UV} + j * \text{BUA} + k * (\text{UV})^2$
- iii) $\text{Stiffness} = p + q * \text{UV} + r * \text{ATT}$

where l, m and n; h, i, j and k; and p, q and r are constant coefficients, and UV, BUA and ATT are determined for the at least one point of the sample.

20. (Original) The system as in Claim 19, wherein i) l, m and n are linear regression constants predetermined by conducting a regression analysis between measurements of UV and BUA on bone specimens and Stiffness measurements on the bone specimens using conventional analysis; ii) h, i, j and k are non-linear regression constants predetermined by conducting a regression analysis between measurements of UV and BUA on bone specimens and Stiffness measurements on the bone specimens using conventional analysis; and iii) p, q and r are linear regression constants predetermined by conducting a regression analysis between measurements of UV and ATT on bone specimens and Stiffness measurements on the bone specimens using conventional analysis.

21. (Currently Amended) A method for determining at least one material property ~~properties of a material bone~~ sample at a point of interest, the method comprising the steps of:

a) ~~placing the sample bone between an ultrasonic transducer and a receiving ultrasonic transducer, wherein both transducers are confocal ultrasonic transducers configured to receive the sample therebetween such that a confocal point is variously positioned on~~ located at a point in the bone sample, and ~~emitting~~ transmitting an ultrasonic signal focused at the confocal point;

b) positioning ~~the bone~~ a material sample so that the ultrasonic signal passes through the material sample ~~bone~~ and such that the a point of interest of the material sample ~~bone~~ lies within the confocal point of the ~~transmitted~~ ultrasonic signal;

c) receiving the ultrasonic signal after ~~it~~ the signal passes through the material sample ~~bone~~;

d) determining at least one ultrasonic parameter for the point of interest of the material sample ~~bone~~ at the point of interest based upon the transmitted ultrasonic signal and the received ultrasonic signal; and

e) determining ~~[[the]]~~ at least one material property at the point of interest of the sample ~~bone~~ based upon the at least one ultrasonic parameter;

f) repositioning the confocal point to another point of interest in the bone;

g) repeating steps a-e to determine additional material properties of the bone; and

h) repeating steps f and g to detect a region of interest in the bone based upon the detected material properties.

22. (Previously Presented) The method as in Claim 21, wherein the confocal point is not greater than 0.5 mm.

23. (Cancelled)

24. (Currently Amended) The method ~~as in Claim 23~~ of claim 21, wherein steps a-g are repeated for an array of points of interest in the material sample ~~bone~~, the array comprising a volume.

25. (Original) The method as in Claim 24, wherein points in the array are separated by 0.1 mm.

26. (Currently Amended) The method ~~as in Claim of claim 22~~, wherein determining at least one ultrasonic parameter for the point of interest of the ~~material sample bone~~ comprises determining the ultrasonic velocity (UV) and a measure of ultrasonic attenuation (UA) for the point of interest.

27. (Currently Amended) The method ~~as in Claim of claim 22~~, wherein determining the at least one material property at the point of interest of the ~~sample bone~~ comprises determining at least one of elasticity, density, shear strength and tensile strength.

28. (Currently Amended) The method ~~as in Claim of claim 22~~, wherein timing signals are provided to a stepper motor for positioning the confocal point to a series of points of interest for detecting the region of interest in the material sample comprises a bone sample.

29. (Original) A system for determining at least one material property of a material sample at at least one point, the system comprising:

a) a transmitting ultrasonic transducer and a receiving ultrasonic transducer, both transducers being confocal transducers, the transducers configured to receive the material sample therebetween such that the confocal point of the transducers are located at the at least one point in the material sample; and

b) a processor that initiates an ultrasonic signal from the transmitting transducers that is transmitted through the at least one point of the material sample when positioned between the transducers and received by the receiving transducer, the processor receiving a signal reflecting one or more measures of the received ultrasonic signal, the processor determining at least one ultrasonic parameter for the at least one point of the material sample based upon the transmitted and received ultrasonic signals, the processor further determining the at least one material property at the point of the sample based upon the at least one ultrasonic parameter.

30. (Cancelled)